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BI & Data Science for architects

'The Building Data Library': an online platform to share and analyse building data

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Synopsis

Data-driven design processes have been increasingly implemented in the training of new generations of architects and have been focused on BIM (Building Information Modeling) both to create and manage building documentation and in parametric design tools to generate complex geometries. At the same time the ability to collect data across the building life-cycle is exponentially growing but, although this digital data management could improve the design quality of buildings in terms of operational performance and user experience, there is still a lack of architects trained in integration and data analytics.

'The Building Data Library', an online platform of analytical 3D models of buildings, tries to solve this issue by applying Business Intelligence (BI) and Data Science (DS) tools to promote digital data management in order to make informed decisions beyond our own expertise and intuition.

These kinds of databases will play a paramount role in a near future where Machine Learning (ML) will lead to the automation of many design processes.

Key words: Data Science; Machine Learning; Business Intelligence; Big Data; Design process.

1. Improving the quality of buildings and cities in terms of data

The AECO Industry (Architecture Engineering, Construction, Operations) is aware that making inappropriate decisions at early stages of architectural design has a huge impact on the social and financial value of buildings¹. Because of that, a lot of resources and investment are aimed at developing tools and processes that minimize risks in the early design stages.

Building Information Modelling (BIM) and Geographic Information Systems (GIS) are methodologies that have emerged as a logical consequence of these huge efforts. In spite of that, as architects and urban planners we know that these useful software implementations minimize errors and speed up design and documentation processes but do not guarantee the design quality of a smart building or city.

To talk about design quality is to focus on how our buildings and cities serve their occupants in terms of operational performance and user experience. Therefore, we need methods to verify the starting design goals in order to correct shortcomings or implement better solutions in our next designs. Collecting and analyzing data throughout the building life-cycle can provide a useful benchmark in order to make informed decisions beyond our own expertise and intuition.

Other business areas and industries have achieved great advances in Big Data analysis. In our field, when we talk about a full portfolio of projects, sensor data, occupancy data, energy data, or even purchase data, we are starting to talk about a large amount of data. And in this scenario Business Intelligence (BI) and Data Science (DS) emerge as suitable methodologies for architects and urban planners.

2. Architects have always worked with data. What's new?

Experts in databases have been overwhelmed by the success of the term 'Big Data', an area that they have been studying for more than 40 years under the name of 'very large databases'². We have the ability to calculate and accumulate information that could hardly have been predicted a few decades ago and storing and conveying information in real time is increasingly affordable³.

This ability to collect data via smart buildings, smart cities and the Internet of Things (IoT) and the speedy advances in Artificial Intelligence (AI) will lead to the automation of many design decision-making processes. Here 'smart' is not only dynamics, it is about managing data, because software and device technology changes rapidly, but data persists. Hence, it is needed to form our design decision-makers in integration and data analytics.

As architects we are used to working with data as a start and end point. We do not produce buildings or cities. We produce instruction documents from pre-existing condition data. In fact, our layouts are documentation views of a digital database: the BIM/GIS model. Although we know that analysis is not

¹ See: The MacLeamy Curve: https://www.researchgate.net/figure/The-MacLeamy-Curve-9_fig1_315359204

² Conference on Very Large Databases VLDB 2018 will be held this year in its 44th edition.

³ In 2015, the storage capacity of public cloud data centers stood at 170 exabytes worldwide.

enough to produce outstanding proposals because our creative process is proactive, the quality of our answers will be determined by our capacity to formulate the best questions. And these emerge better from an accurate management of a large amount of unstructured data.

3. 'The Building Data Library', a collaborative platform to share and analyse building data

How can we implement this digital data management to improve design quality of buildings in terms of operational performance and user experience?

First, by using BIM software to build databases of spatial 3D models that work as data repositories throughout all phases of a building life cycle (design, construction and operations). Second, by integrating and analyzing data with BI tools. And third, once the volume of data is significant, by developing predictive models based on Data Science methods.

To contribute to spreading this workflow among architects we are launching 'BILI. The Building Data Library' (Fig. 1) An online collaborative platform of analytical 3D models from exemplary buildings that visualize their most relevant data, space planning, performance and key design features, through BIM and BI tools.

Applying spatial analysis of outstanding building samples that have been tested by the passing of the time, expert opinions or optimal post-occupancy evaluation, can be a useful starting point to introduce a design process based on digital data management.



Figure 1.

4. How BILI applies Building Intelligence & Data Science methods

A methodology based on BI and DS should take into account the following steps: collecting, processing, analyzing, predicting. Our workflow redefines them:

- Extracting: scraping tools, text mining, sensors, websites, post-occupancy surveys, social networks...
- Processing: data wrangler tools and data integration (ETL).
- Modelling: databases design and analytical BIM modelling.
- Visualizing: BI dashboards and maps, BIM viewers.
- Improving: Genetic Algorithms based on Neural Networks⁴

Our online platform: 'thebuildingdatalibrary.com' develops this methodology by defining two sets of building data: 'Datacard' and '3D Model'. (Fig 2).

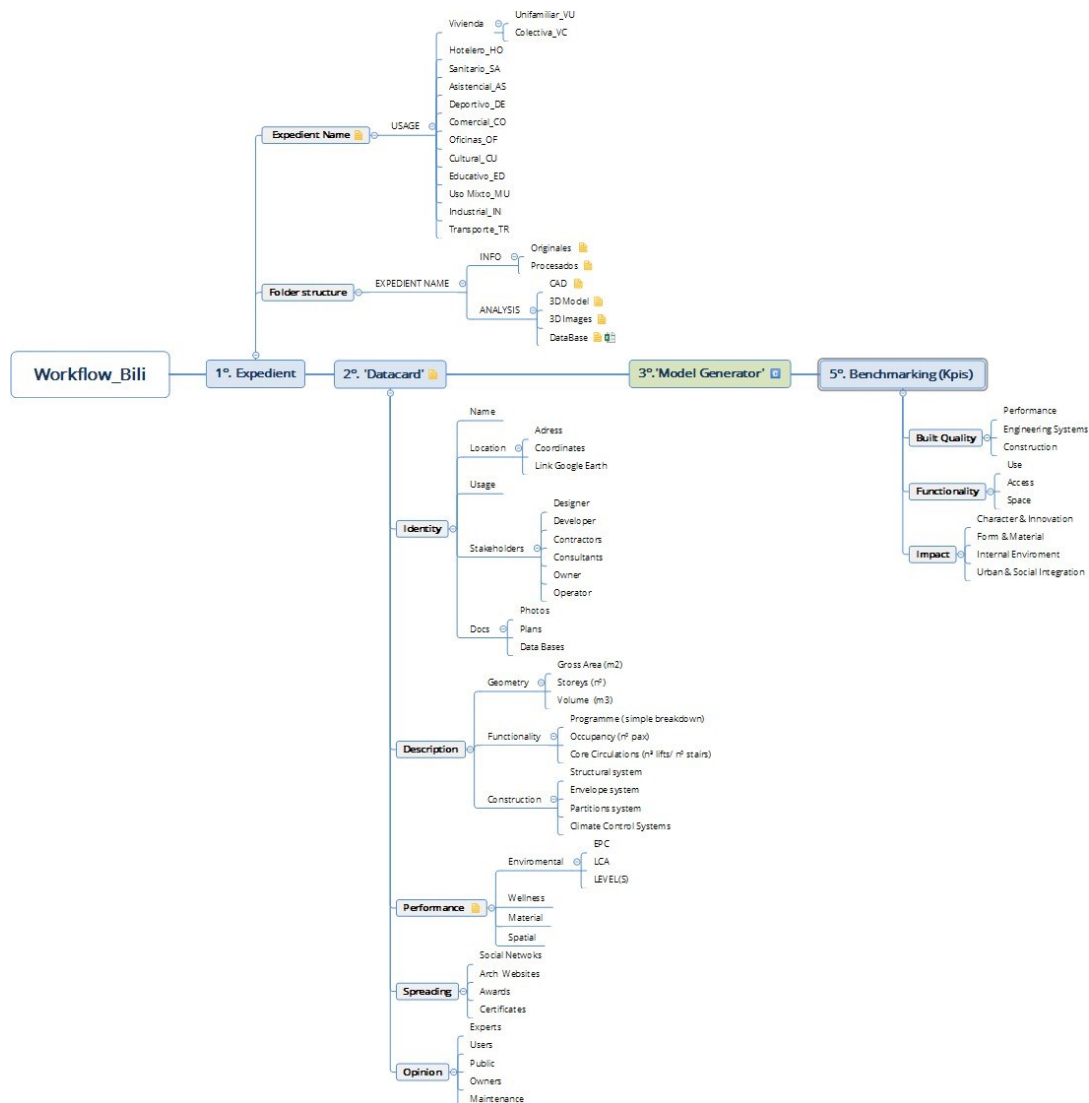


Figure 2.

⁴ There are a lot of interesting experiences about space planning optimization: see 'Autodesk MaRS Office by The Living Studio. <https://vimeo.com/193915345>

'Datacard' gathers building attributes in five categories: Identity, Description, Performance, Spreading and Opinion. '3D Model' is produced using an automated process called 'Model Generator' and it is based on room spaces with semantic attributes. At the moment we analyze: Usage, Core, Circulations, Volume, Public, Evacuation and Shape.

Both 'Datacard' and '3D Model' can be mapped with new data categories at any time, for example to collect post-occupancy evaluations.

Finally, we could benchmark the design quality of the building with aspects defined by the Design Quality Indicator (DQI)⁵: Build Quality, Functionality and Impact.

5. Laying the groundwork for an ML-based architectural design

Collecting, analyzing, visualizing and predicting data can help stakeholders in the AECO Industry make better decisions, but everybody knows that advances in the field of Artificial Intelligence (AI) allow computers to find a faster and optimal solution to a problem or a task.

Machine Learning (ML), a subset of AI, can provide us with the ability to transform learned data into architectural proposals by using algorithms. If we focus on the branch of Reinforcement Learning (RL), we can find tools oriented towards this design optimization in the family of Genetic Algorithms (GA) where a 'fitness function' could determine, among thousands of possible solutions, the design quality of the candidates.

Fortunately, the community of programmers in this field is growing increasingly faster and ML does not require much advanced programming learning on behalf of architects, only a large amount of data to work from. And here is where a platform of 3D models like 'The Building Data Library' could play a paramount role.

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⁵ <http://dqi.org.uk/>

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Biography

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With an accumulated know-how of 20 years developing architectural and urban design programs, several projects awarded and published in architectural media, broad experience in architectural competitions and more than 15 years using BIM methodology, nowadays I am involved in an innovative web platform: 'The Building Data Library', in order to develop my passion for technology and Architecture.

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